Name: _____ Class: _____ Date: _____

Electricity and electrical charges

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CONCEPT REVIEW 19

Complete this concept review handout and keep it as a record of what you have learned..

Definitions

- Electricity describes *all the phenomena caused by positive and negative charges.*
- Electrical charge is *a property of protons and electrons. A proton carries a positive charge, while an electron carries a negative charge.*
- The coulomb is *the unit of measurement for electrical charge. One coulomb is equal to the charge of 6.25 × 10^{18} electrons or protons.*
- An electrical field is *the area of space in which the electrical force of a charged body can act on another charged body.*

Electrical forces of attraction and repulsion

Electrical charges of like signs *repel each other.*

Electrical charges of opposite signs *attract each other.*

The law of conservation of charge states *that electrical charges can be neither created nor destroyed; they can only be transferred from one body to another.*

Conductors and insulators

Category of object	Definition	Examples
Conductor	*Substance that permits the free flow of electrical charges.*	• *Metals* • *Electrolytic solutions*
Insulator	*Substance that impedes the free flow of electrical charges.*	• *Nonmetals (usually)* • *Wood* • *Plastic* • *Glass* • *Ceramics* • *Paper* • *Silk* • *Rubber* • *Air*
Semiconductor	*Substance that exhibits variable conductivity, depending on different factors.*	• *Metalloids* • *Carbon*

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INTEGRATION QUESTIONS

Electricity and electrical charges

1. Where do electrical charges come from?

Electrical charges come from the electrons and protons that form atoms.

2. In the course of an experiment, Justine observes that the two objects she charged previously repelled each other. What can she conclude from the signs of each object's charge?

If the charges repel each other, it is because they each have the same sign.

3. In each of the situations below, state whether it is a conductor or an insulator.

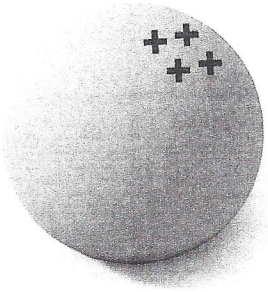
a) A solution in which electrodes have been immersed, causing a light bulb to light. — *Conductor.*

b) The rubber sheathing of an electrical cable. — *Insulator.*

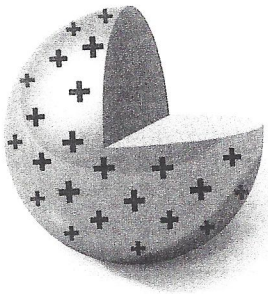
c) A lightning rod composed of a metal rod and metal cables attached to the ground. — *Conductor.*

d) The ceramic installed on transmission towers. — *Insulator.*

e)

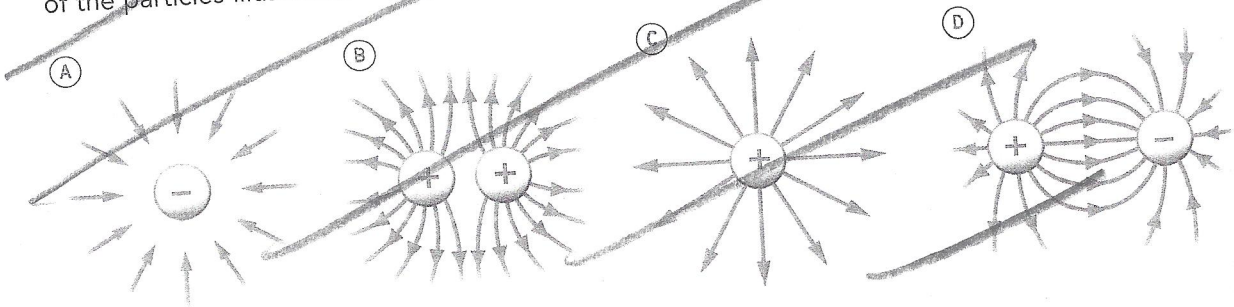


An insulator.



A conductor.

4. The following illustration uses electrical field lines to represent various electrical fields. Considering that the lines indicate the direction of the force that would be exerted on a positive charge placed in the field, write the signs of the charges carried by each of the particles illustrated below.



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Static electricity

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CONCEPT REVIEW 20

Complete this concept review handout and keep it as a record of what you have learned.

Definitions

- Static electricity describes *all the phenomena related to electrical charges at rest.*
- Coulomb's law states *that the magnitude of the force between two immobile and electrically charged particles is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.*

Mathematical formula and units of measurement for Coulomb's law

$$F_e = \frac{k q_1 q_2}{r^2}$$

where F_e *is the electrical force (in N).*

k *is Coulomb's constant, which is* $9 \times 10^9\ Nm^2/C^2$.

q_1 *is the charge of the first particle (in C).*

q_2 *is the charge of the second particle (in C).*

r *is the distance between the two particles (in m).*

Three methods of charging an object

Method	Before	During	After
Friction	*Two neutral objects*	*Friction pulls electrons away from one of the objects and transfers them to the other.*	*Two objects with opposite charges*
Conduction	*One charged object and one neutral object*	*The charge of one object is shared between two objects when they come into contact.*	*Two objects with like charges*
Induction	*One charged object and one neutral object*	*The proximity of the charged object causes the charges in the neutral object to separate.*	*One charged object and one object carrying a partial positive charge on one side and a partial negative charge on the other side.*

Name: _____ Class: _____ Date: _____

INTEGRATION QUESTIONS

Static electricity

1. In the situations below, which means of charging has been used?

a) On a dry day, Eric reaches to stroke his cat and its fur stands up in the direction of his hand. — *Charging by induction.*

b) A balloon sticks to the wall after being rubbed a few times in someone's hair. — *Charging by friction.*

c) A charged object shares its charge with another object. — *Charging by conduction.*

d) When a piece of jewellery is wiped with a dry cloth, it is observed that both objects are charged. — *Charging by friction.*

2. Why do we sometimes get an electrostatic discharge when we touch a metal object after walking on a carpet?

Answers will vary. Example: When we walk on a carpet, we charge our body by friction. When a charged object (in this case, our body) comes in contact with a conductor (for example, a metal object), an electrical charge is produced, which causes the electrons to pass through the air, and the object charged to recover its neutral state.

3. A student places two objects, each carrying a positive charge of 7×10^{-7} C, 3 cm apart.

a) Calculate the electrical force that each object exerts on the other.

$$F_e = \frac{kq_1q_2}{r^2} = \frac{9 \times 10^9\ Nm^2/C^2 \times 7 \times 10^{-7}\ C \times 7 \times 10^{-7}\ C}{(0.03\ m)^2}$$

$$= 4.9\ N$$

The electrical force exerted on each object is 4.9 N.

b) Is the force acting on the objects a force of attraction or repulsion? Explain your answer.

It is a force of repulsion because the two objects carry an identical charge.